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THE AVALANCHE ZONING PLAN

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I. History of the Avalanche Zoning Plan

On March 6, 1928, the federal forest inspector Dr. F. Fankhauser delivered a lecture on avalanches and avalanche defenses in which he said, "If certain sites known to be endangered have recently been sold to strangers for house construction, so that in some cases an outlay of millions is required to correct the already-committed error by means of defense structures, then this should serve as a lesson for the future and induce community officials to deny construction permits where such danger exists." This was not only said but written down 40 years ago. Unhappily the words have had little of the apparent effect they should have had. This negligence has exacted a bitter revenge in many localities.

The situation is not a new one; buildings erected long ago in danger zones sooner or later fell victim to avalanches. There is no truth in the widely heard rumor that the ancients knew exactly where and where not to build. Sooner or later very old buildings have been destroyed by avalanches, and even whole villages wiped out.

The heavy construction activity in recent decades gave rise to local planning activities. In all cases these have to take avalanches into account. Avalanche zoning thus is a permanent part of local planning by means of which avalanche damage can be prevented. In this respect the expression "avalanche zone planning" is correct. Objectively better and more correct would be the designation "avalanche zone mapping", since avalanche zones are not the product of planning; on the contrary, they often come in conflict with planning, a factor which has great legal significance. Avalanche zones do not arise from the desires of planners, but are imposed on them as natural forces independent of human influence. The already-adopted expression "avalanche zone planning" is justified if it is understood to include the whole complex of tasks involved in preventing avalanche damage which are addressed to technical as well as legal and administrative problems.

Localities available to foreigners in the mountains have not grown up only in recent times. The growth resulted in part from a lack of space in areas which were known to be avalanche districts. A period of avalanche inactivity sooner or later allows the hazard to sink into forgetfulness. O. Lütschg-Loetscher wrote about the health resort of Davos in 1943: "Because the health resort began to develop in the last quarter of the 19th century, more than a generation after the disaster of 1817, construction was most intensive on the sunniest, but most severely endangered, part of

Davos. Warning voices should definitely have been raised against this, but, since most of the construction was undertaken by people unacquainted with the area who paid the natives high prices for the land, the warnings didn't get through."

For his part, Fankhauser spoke only of building permits which should have been denied. Later the Federal Forest Inspectorate took up the matter once more. After the great avalanche catastrophes of winter 1950/51, the Federal Department of the Interior published guidelines in which the necessity of avalanche zoning plans was emphasized. Seven years later, on July 9, 1959, the proclamation addressed to the governments of the mountain cantons was repeated, in which the instructions were recalled with the following words: "The guidelines of our Department of June 17, 1952, concerning afforestation and defense projects in tracts exposed to avalanche danger contained certain instructions intended to minimize the future exposure of human life and structures to avalanche danger. These instructions read as follows:

> "The preparation of avalanche zoning plans and avalanche cadasters is indispensable if future loss of life and property is to be prevented..... The Federal Government cannot underwrite contributions to resettlement or measures to protect structures against avalanches if the construction site was chosen without regard to the avalanche zoning plan and cadaster, or if such is lacking, warnings of building commissions were disregarded."

"Experience teaches that the avalanche catastrophes of 1951 and 1954 are all too soon forgotten and that today construction is beginning again with irresponsible carelessness in avalanche danger areas. The people involved must bear the responsibility for their own lack of foresight, for the Confederation, in conformation with the above-mentioned guidelines, cannot contribute to the cost of protective measures."

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Up to the end of the 50's the farmers of Davos and Verbier had used as they had for centuries their mowing meadows "auf den Böden", "Mayentset" and "PlanPra". In the autumn the cows grazed, the manure was put out to the meadows, and in summer the aromatic mountain hay was harvested. But the migration of mountain-people into the towns had long since begun. Again and again, "Maiensässe" were given up and even the less productive land was relinquished, for no more mowers could be found to cut the grass for poor compensation. The land became cheap. On the other hand, good economic conditions and the wealth of the lowlands brought more and more vacationers to the mountains. Among these were many who could afford a second, or vacation, house. By the early 50's, the hunger for land extended to mountain areas. The sale of stony acreage in a short time made the mountain farmers rich. Speculators smelled business, got into the act, and soon ferreted out

the poorest and most remote corners of land. Areas bought en bloc were subdivided, designated as construction sites, and parcels sold at truly high connoisseurs' prices. The "construction sites" also included avalanche areas. But the buyers for the most part did not come from local areas and many were even foreigners. These people hardly ever noticed the serious drawback of their "piece of building land", or noticed it only after it was too late.

The situation of the construction land and real estate markets in the best-known vacation resorts can best be shown if we recall the measure against land speculation which, among other things, led to the "Mandatory Permission for the Acquisition of Land Parcels by Foreign Persons." The "sell-off of the homeland" was widespread in 1960. For instance, the Senate of the Grisons took up this matter. In the session of 27 May 1961 a member of the Senate declared: "Foreigners own 71 parcels of land in Davos, 69 in St. Moritz and 99 in Arosa." In the 13 September 1960 session of the Senate of the Canton of Berne, Senator Gertsch inquired about which communities had avalanche zoning plans and which courts were competent to draw up and approve these plans. The reply was that not a single community of the canton had a finished plan. On 29 May 1962, Senator O. Largiadèr from Pontresina posed a parlimentary question concerning protection against avalanche damage. This reads as follows:

> "As a consequence of the current construction boom, vacation homes in some communities are being built without consideration and foresight in avalanche paths. The 17 June 1952 Guidelines of the Federal Department of the Interior concerning afforestation and defense structure projects in avalanche hazard zones contained certain instructions designed to insure when possible in the future that lives and property were kept free of avalanche danger. In this same regulation, among other things the preparation of avalanche cadasters and zoning plans was required. The communities were also held responsible for suppressing construction planning in endangered areas. The most honorable Council is requested to impart information about who in the canton of the Grisons is responsible and ready to prepare these avalanche zoning plans. Does not the government accept the interpretation, that the required precautionary measures should be accorded more importance?"

We have taken a notice from the Neue Zürcher Zeitung of 3 November 1962, which is captioned "Expensive Vacation Homes are Built in Avalanche Paths". The notice reads as follows: "Chur, 2 November. The Council of the Grisons must presently act on the following: A scarcity of land suitable for construction has become apparent, especially in certain well-known resorts. This has led to the sale of avalanche hazard zones as construction sites. Furthermore, during the past summer numerous vacation homes have been erected on terrain which is not safe from avalanches."

The extent of construction activity in such resorts can be measured by the example of Davos (1950 permanent population: 10,500), for which the following figures on new housing starts have been taken from the newspaper

"Die Volkswirtschaft": In 1959, 23 houses; in 1961, 47 houses; in 1963, 99 houses. The building activity thus has doubled every two years. Further examples are taken from a report of a regional planner who is familiar with conditions in the canton of the Grisons: "At one locality in the Upper Engadine with 221 residents, construction sites worth Sfr 2,000,000 were sold in 1964. At a thoroughly remote locality at the same altitude with 71 residents and situated around 700m above the valley road, a single corporation carefully acquired land for 30-40 houses. From other places whose names previously had been hardly known, similar alarming reports are arriving, accompanied by pleas for help, "what shall we do?".

Who should assume responsibility for the avalanche zone planning? This question was also posed by the Federal Forest Inspectorate, which has repeatedly pointed to the importance of avalanche zone planning. The Legal and Appeal Service of the Federal Department of the Interior discussed this question on 16 April 1961, in which it was stated: "Preparation of avalanche zoning plans is the affair of the mountain cantons as well as the communities endangered by avalanches. An expert opinion on the various legal aspects of avalanche zone planning points to concern for safety of the residents as primarily the responsibility of the local community. Since ancient times the community has been assigned to the local police by prescriptive rights. Inasmuch as the cantonal laws permit them to prepare zoning laws, the handling of avalanche zoning plans also falls within their competence." But only rarely do the local authorities have experts available who would be capable of executing the technical task of mapping avalanche zones. This is also clear from the proceedings of the 6 June 1962 conference of cantonal Forest Supervisors from the mountain cantons. The notice reads as follows: "The communities are not technically qualified for the preparation of a zoning plan; the forest services must assist them. The forestry officials as overseers of avalanche defense practice are obliged to serve the communities--when requested--as technical advisers on avalanche zone planning." This suggestion was especially appropriate because the forestry officials by reason of their professional expertise in delineating avalanche occurrence, especially in regard to timber damage, were the best-prepared to offer objective opinions about avalanche dangers at individual areas.

"The Forest Inspectorate of the canton of the Grisons in the year 1872 had already issued a memorandum to the district forest officials assigning the task of collecting avalanche statistics and filling out the related forms. After the confederation in 1874 established a Forest Inspectorate, the federal department involved set out the project of accumulating avalanche statistics from the entire Swiss Alps. On 7 January 1878, the cantons were invited to have their forest personnel work toward this goal. These statistics included relevant historical facts about individual avalanche paths, such as unusual events associated with release and fall, size and character of effects and damages, accidents to persons and animals, unusual amounts of deposited snow debris, and similar data." This was written 89 years ago by the then Federal Forest Supervisor J. Coaz. The avalanche statistics were terminated in 1909 and published by Coaz in 1910. If we

still had the original survey and if the statistics had been carried forward to the present, we would be close to a century-old avalanche cadaster, which would provide an outstanding foundation for avalanche zone planning. The two works of Coaz are interesting and valuable mines of information. Unfortunately, the accompanying avalanche map of the Swiss Alps to a scale of 1:250,000, even though a great achievement at the time, is not adequate for executing avalanche zoning plans. The original surveys in scales of 1:50,000, 1:25,000 and 1:100,000 cannot be located and were never continued. Another start was made following the avalanche winter of 1950/51. The Swiss Federal Institute for Snow and Avalanche Research (SLF Institute) began in 1955 the survey to build a new Swiss avalanche cadaster. In 1962 the cooperative work of the SLF Institute and the cantonal forest services was newly organized and the previously limited work was intensified.

It became necessary to train the needed specialists, not only for mapping avalanche areas, but also to introduce the representatives of local governments to their new responsibilities. The Federal Forest Inspectorate therefore directed the SLF Institute to give courses for people working on avalanche zone planning. The first course of this kind was given on 8-9 November 1962 in Davos. It was attended by 27 participants from all the mountain cantons except Schwyz and Obwalden. Representatives of local government and building departments, forest engineers, foresters, civil and cultivation engineers as well as a representative of an insurance dealing with damage caused by natural elements were among the participants. A second course was given 10-12 April 1967. While the first course was given to clarify questions on technical, administrative and legal aspects of avalanche zoning, the second course concentrated on mapping. For this reason, almost all of the 38 participants were forest service representatives, among whom were four Austrians. The Working Group for avalanche defenses, a dozen competent forest engineers working on avalanche control structures, was also interested in the problem of avalanche zone planning.

The first attempt at planning avalanche zoning was documented by the SLF Institute in regard to an extension and alinement plan for the settlement of Wengen on 30 September 1960. For the first time, problems dealing with the delimitation of avalanche-safe and avalanche-dangerous areas were discussed. Until 1968, most of the solutions then proposed were incorporated in more or less unchanged form in all new plannings. Even then it was obvious that an unquestionable separation of safe and dangerous areas could not be achieved. It became necessary to introduce a zone of transition between areas often proven to be swept by avalanches and areas proven to be safe from them. This zone of transition could not be considered totally safe from avalanche danger; however, the danger represented was so small that there was no justification for prohibiting construction in these areas. It became common practice to determine three zones. In definite avalanche areas, construction was prohibited and they were marked on maps in red color. The red zone was followed by a blue zone. In these areas, prohibition of construction was not justified; however, the possibility of danger was not excluded. An area that was definitely without danger from avalanches was designated as a white zone. The blue zone had in addition the special

designation of an "imposition zone", which means that construction was permitted. However, building permits were issued with the understanding that the kind and form of building could be specified, as well as necessary reinforced construction or evacuation of the inhabitants in case of avalanche danger.

After the avalanche catastrophes on 26 January 1968 in Davos where the area "Böden" was especially hard hit, yet for which zoning maps existed, the question was raised if the SLF Institute practice of designating building zones was correct. Essentially, the researcher working on avalanche zoning maps should subdivide areas according to the degree of danger present. The government could then draw the line with respect to the use of the area for construction purposes and the kind of buildings that would be permissible.

At the conclusion of this historical survey, the question must be asked: How much has been achieved to this point? Unfortunately, avalanche zone planning was faced with the same problem as the planning of other projects such as street planning, village planning, etc.; that is, it was behind the actual needs. The people that were directly involved in this cannot be blamed, since they generally directed their efforts toward correcting this situation. It is the public that should be blamed, since it shows interest in a situation only after problems have developed, yet the planner is dependent on its attitude. This is tragically demonstrated with water protection projects. In a lecture, "Building Politics in the Area of the Grisons--a prospect for Ten Years," given on November 23, 1966, Walz said, "A development has been noted for the last ten years that properly can only be called overcrowding." This proved to be true. Local governments of most involved communities, as well as building police and construction planning, were totally surprised and unprepared. Only under these circumstances was the project of avalanche zone planning initiated. Landowners, however, strongly objected, since they were interested in their property only as potential building sites. In many cases, reclamations were made before work was started on the project and hardly was planning finished for the priority areas when the first appeals were started by property owners. In perspective, the interests of property owners, as in most cases, is guided purely by the desire for making money. Speculation is mostly unchecked and it is shameful to see how wealth and money will turn people brutal and rotten. Questions dealing with ethics and human relations should be just as important as questions dealing with technology, legalities and administrative skill.

The problem could have been solved easier if notice would have been taken of the timely warning given by the Federal Forest Inspectorate. In any case, we should learn from our mistakes. Most avalanche zone planning has remained piece-work until today, mainly because extensive areas had to be neglected in order to deal with priority areas. We know of very few mountain communities that have planning which cover all the areas in question. In this respect, the outstanding efforts of the canton Nidwalden should be mentioned. Here the government systematically surveyed the whole

area of the canton to determine the need for avalanche zone planning. This canton is the only one which has a detailed law concerning avalanche zoning plans, which went into effect April 24, 1964.

The serious avalanches in January 1968 drastically demonstrated the need for avalanche zone planning. On 5 February 1968, Senator Hubacher introduced the following bill/postulate to the Senate of the canton of Berne: "The government is asked to investigate the possible methods of constructing an avalanche zoning map for mountain areas. The latest avalanche occurrences have shown that such a map would not only be beneficial for the local people, but also for the tourist trade and for the building of tourist facilities, since it would give information on possible avalanche paths. In this connection, the question is raised if in areas designated as avalanche zones, construction should be prohibited, and if avalanche zoning could be used as a basis for an avalanche cadaster, which, analagous to the torrent cadaster, could be used for the promotion of structural avalanche control. The avalanche zoning map should also include every known avalanche path. Complete information is probably not possible, and no government responsibility could be linked to such a map. It should be used only as a guide."

In the press release, the Federal Forest Inspectorate also focused attention on avalanche zoning plans: "Because of observations made this winter, it is necessary to focus additional attention to organizations such as the Avalanche Warning Service in these regions, and to the so-called Passive Avalanche Defense that deals with the mapping of avalanche zones in which provisions have been made to restrict construction and which include building specifications."

As a result of a bill/postulate introduced by Representative Leu on 5 March 1968, the Diet (representatives of the cantons in the Parliament) will also have to deal with avalanche zone planning. This bill/postulate demands a thorough investigation on how law could be applied to inhabited areas to force the construction of avalanche defense structures and to prohibit construction in danger zones. A bill introduced to the National Council by Senator Grünig on 6 March 1968, states the following: "Thought should be given to a possible speedy establishment of an avalanche cadaster that would encompass all areas in Switzerland, especially since such a cadaster has already been demanded by different cantonal parliaments. Such an avalanche register would be prerequisite for avalanche zoning according to Article 32, Section 1. It would also constitute a solid basis for additional and necessary control structures. It would be an important part of indispensable national and regional planning in the mountains."

On the whole, avalanche zoning in Switzerland is still at its beginning. It can be proofed by some figures how big the task is which should be set about doing now. In the twelve mountain cantons of Berne, Uri, Schwyz, Obwalden, Nidwalden, Glarus, Fribourg, St. Gall, the Grisons, Tessin, Vaud and Valais there are 312 communities that need avalanche zone plans. Of these only 29 or 9% have such plans which often are not complete and extend only over part of the whole territory. These 312 communities extend over 1.5

millions of hectares. After deducting unproductive surfaces and the forested area there are still 664'280 hectares for which zoning plans must be prepared. The plans elaborated up to now comprehend a surface of 29'480 hectares or 4% of the total. The rest namely 96% have to be treated yet.

II. Concept and Description of the Avalanche Zone

An avalanche zone can generally be subdivided into three sections: a starting zone, a track and a runout-damage zone. Since the building authorities need to know only the conditions of the inhabited areas and potential construction sites, which are mostly located in the runout zone, the starting zone and the track are ordinarily not included in zone planning. However, workers compiling the avalanche zoning map must also judge the starting zone and the track. It is from the characteristics of these areas that the size, runout distance and frequency of expected slides can be estimated.

If the starting zone is uniform, chances are that the slide is released over the full extent of the zone, which results in a large avalanche. If it is separated by rock outcroppings, forest patches and ridges, small slides will frequently release, but the resulting avalanches will be small and harmless. Slopes with an inclination of 60% or more can generally be considered avalanche starting zones; however, a slide will break loose only under certain weather conditions. The most important factor which is necessary to release an avalanche is heavy snowfall. A large amount of snowfall will result in new snow avalanches that can be dangerous for inhabited areas. Under conditions of heavy snowfall, the rapidly increasing new snow layer cannot settle and stabilize enough to bond with the old layer of snow or the ground below it, so that after a given amount of time the new snow layer will slide off as an avalanche. Steep slopes with approximately 30cm of new snowfall represent a local slide danger. If the snowfall accumulates to about 50cm, the expected avalanches will be larger, but if it accumulates to about 70cm, avalanches release in areas that seldom experience them. An important factor in judging avalanche areas are slopes with an inclination of between 55% and 60%. Such slopes do not release immediately under heavy snowfall, allowing for exceptionally large avalanches, as was demonstrated in the winter of 1950/51.

Along with the new snow avalanches which usually occur in mid-winter and which are composed of dry and light snow, spring and ground avalanches should be mentioned. Their release is effected by warm and clear weather and by strong solar radiation or by the "Föhn", all factors which cause the entire meltwater-saturated snow layer to slide along the ground. The wet and heavy snow moves relatively slow and generally follows a well-known slide path. Ground avalanches are especially important to transportation and communication links, such as railroads and highways.

On slopes and in gullies with an inclination of about 30%, avalanches will not ordinarily stop in their downward movement. Slopes with such angles must still be counted as part of the track. The average inclination for most avalanche paths that extend for a long distance is between 40% and 70%. The

direction and run out distance of an avalanche in the area of deposit is determined by the form, direction and slope of the lower area of the track. According to their type and by the corresponding shape of the track, avalanches can be thrown out of their path and can follow totally different directions. In one instance, it could be observed that the advanced fronts of ground avalanches and dust avalanches (a snow-air mixture) were deposited 400m apart, even though they released from the same zone. The different dynamics of two types of avalanches result in a much larger area of deposition than is observed with only one type of avalanche. The possibility of building on alluvial fans below the mouth of gullies must often be considered. Avalanches are channeled in the gullies and enter, at the beginning of the outrun, a relatively flat and wide terrain. Retardation often begins at the gully mouth. The outrun distance of large avalanches is long, despite the small inclination of the slope. At inclinations of 10% to 15%, outrun distances of 500m to 1000m are observed. On a steep and irregular track, dry snow avalanches develop into powder avalanches of respectable size. The resulting impact can lead to destruction at places which cannot be reached by the sliding snow. In narrow valleys, the air blast can reach far up the opposite slopes.

As a result of unusual weather conditions, avalanches can occur at places where it was never considered possible. A combination of low temperature and intense snowfall can lead to an unusually loose snow layer that can even release in forested areas. Mountain forests in general and especially larch forests show thin open stands which are not able to prevent the starting of avalanches. The avalanches from January 10-12, 1954, which especially affected the Grosse Walsertal in Austria are a case in point. Schilcher said following the event: "From the southern and partially from the northern valley slopes of the Grosse Walsertal, loose snow and dust avalanches of all sizes spread over 50% of the total area. The release areas existed along the length of the valley and were scattered in a southwesterly direction at any height between 800m and 1850m and were located in open country as well as in forests." Such possibilities must be strongly considered, since sunny ridges located under steep mountain forests make ideal locations for summer houses.

Another local source of danger is gliding snow. This is the slow and not often noticeable movement of the snowpack along the ground. It is observed that these phenomena occur most often on steep mowing meadows in the snowy foothills of the Alps. However, more gentle snow slopes are also subject to dangerous movement if they are water saturated. Early and heavy snowfall results in pronounced "glide winters." Recent examples are the winters of 1952/53 and 1965/66, in which many buildings were damaged.

The return interval of individual avalanches is the source of most difficulties for a sensible approach to an avalanche zone designation. We mean avalanches that are infrequent and extreme. It is these avalanches that are most dangerous to inhabited terrain, since they generally sweep large areas. In this respect, peculiar opinions have been expressed. For example, an

appeal was filed against withholding a building permit for construction of a vacation house. The reason given was that a situation conflicting with safety laws only exists if "immediate" danger is present. Avalanches that only sweep down occasionally do not present immediate danger. It is possible to give information on the frequency and probability of avalanches by analyzing weather and avalanche statistics. However, since a slide event cannot be predicted in advance, this information is practically useless. This problem can be stated with an example as follows: Should an area that in a span of one hundred or several hundred years recorded only one avalanche be proscribed for building projects? We can imagine such an event occurring the following winter. The reader will arrive at the conclusion that construction would be irresponsible. But if the event is imagined in the distant future, a totally different reaction could be expected. Such problems were recently discussed openly in connection with the avalanche catastrophe "Auf den Böden" in Davos. De Quervain wrote: "To eliminate every possible risk by considering regular avalanche activity and every historical avalanche event as a basis for zone planning, several well-known resorts had to put under the ban entire quarters. A certain final risk in the future must be accepted even if only one serious catastrophe occurs in hundreds of years, or if more frequent but less serious damage is inflicted. The extent of the risk for the different area sections should be evaluated by people that have knowledge of the area or, if possible, by an avalanche expert. The final evaluation on what is reasonable has to be left to a judicial court."

The Avalanche Zoning Map should incorporate every danger associated with snow. Factors that should be considered are the type of avalanches, air blast caused by dust avalanches, the erratic path taken by wet snow slides, the creeping and sliding movement of the snow cover and unusual and extreme events. The thankless job of determining the extent of risks to be taken, by defining areas where building should be specified or construction prohibited, is left to the government. Together these constitute the avalanche zoning plan, which then presents the blueprint for local planners.

III. Avalanche Zone Mapping

Mountain communities are often scattered over extensive areas with much unproductive terrain which is characterized by boulder fields, rocks and glaciers. To illustrate this, the five largest communities have been selected:

Community	Total Area	Unproductive Terrain	Percent
Bagnes VS	28'230 ha	18'800 ha	67
Davos GR	25'378 ha	6'780 ha	27
Zermatt VS	24'336 ha	21'800 ha	90
Evolène VS	20'997 ha	12'800 ha	61
Zernez GR	20'550 ha	7'240 ha	35

Avalanche zoning maps that are mapped according to communities will later become an addition to community building regulations. Avalanche zone mapping ideally should include the total area of a community. However, little would be accomplished by including the large barren and uninhabited terrain. Mapping can then be limited to settled areas, potential building sites and regions with existing or potential commercial links. Border areas with uniform topography separating two communities should be dealt with according to principles that apply to planning in general; such areas should be considered as a unit. Mapping should not stop where the areas of two communities meet, despite a political division of uniform topography.

Sources of information available to researchers compiling avalanche zoning maps are:

-Topography and forested areas

-Avalanche scars in the terrain

-An eventual avalanche register (cadaster)

-An eventual avalanche chronicle

-Statements of local people

Practice has shown that the general plan for the register of land property at a scale of 1:10,000 can be used as an excellent foundation for studying the topography. Another valuable perspective can be gained by using the National Map with a smaller scale of 1:25,000, which is not yet obtainable for all mountain areas. At a contour interval of 20m, this map does not show detailed land forms; however, it can be used as a stop-gap if the general plan is missing. Large maps have the disadvantage of being hard to handle, especially if large areas must be worked. They lose a great deal of clarity, which should not be sacrificed for exaggerated details. It is easier to record on larger scales, as for example 1:5,000 or 1:2,000. Yet such maps with altitude contours exist only for small areas. It is advantageous to inspect survey maps for possible avalanche areas, record them approximately, and then verify their existence in the field. Under these circumstances, mapping can be done confidently and efficiently. The study of topography is the most important undertaking since all other sources of information can give only data on avalanches that actually have occurred. Topography shows all the potential avalanche areas, as well as those of avalanches which seldom occur whose scars have disappeared and which have not been recorded in a chronicle or avalanche register.

The forest is important for avalanche defense, especially at the starting zone. Its effect and importance with respect to the slide path and outrun area is often misunderstood. Forest growing in the slide path can divert small avalanches and if conditions are favorable, stop them. Recording small avalanches however for mapping purpose is useless. We need to know the area of the large ones. These will sweep the forest away, and much damage can be

caused by the ram-effect of tree trunks carried down with the slide. The four tree species which occur in our mountain areas are of (have their) specific meaning for avalanche mapping. For example: avalanches seldom occur in areas forested with dense, large and old stands of spruce (Picea excelsa), cembra pine (Pinus cembra) and mountain pine (Pinus montana). On the other hand, caution must be exercised with scattered small stands or small strips of these species remaining on ridges. They convey the impression of being a closed barrier, which is, however, easily swept through by avalanches without causing any damage to the stands. In summer, a deceptive picture is projected by the shrub-like form of the mountain pine or dwarf-pine. The dense and tall shrubs give the impression of constituting an effective barrier against the release of slides. Such stands are pressed to the ground in winter. Dwarf-pines escape damage even when swept by large avalanches. The larch (Larix decidua) is very resistant to slides because of its tough wood, its strong roots and its limberness in the sapling state. Trees ten meters tall can be bent to the ground and be overrun without breaking. Such trees will regain their erect position after the weight has been lifted. Similar observations can be made about resistance to creep and glide of the total snow cover. An open and old stand of larch can be swept by large avalanches without being damaged. More confusion is added by the fact that in summer, these trees have needles and give the impression of a closed stand, which is not true for winter when the needles are shed.

A forest is often scarred by avalanches. Stands of young trees of the same age which grow on the edge of the avalanche path indicate that avalanches occasionally occupy a much wider path. Trees without branches could have been growing at one time in the path of an avalanche. Remains of forests swept or carried down by avalanches can be used for avalanche mapping long after the snow has melted. These scars often show the extent of an avalanche better than the snow that has been carried down, since new snowfall and wind can obscure the latter. The forest is of additional importance with respect to construction, which becomes apparent only with the development of the avalanche zoning plan. Forested areas fall under different legal regulations. To build in the forest requires the clearing of a wooded area. Even if the building enthusiast could use an open area within a forest, it would be the equivalent of clearing, as is true of any claim to forest lots which become temporarily or permanently changed. Since foresters and community authorities of certain cantons may have no knowledge of this definite federal regulation, all mountain forests should be declared off-limits for construction and mapped in red.

We know of avalanche evidence which the layman would not consider possible. The large "Breitzug" avalanche that swept down in the area of Davos on January 26, 1968, dislocated rocks with a diameter of up to 1.6m. The rocks were picked up from the bed of the "Landwasser" and carried over a distance of 66m with an altitude difference of 14m up the opposite slope. The slope was covered with fist- and head-sized stones. A rock 9m long and 4m high can be found on the old Susten road, 500m behind the village of Obermad. An attached plate contains the following inscription:

Nature Monument

protected by the state

On February 15, 1928, this rock

boulder, weighing approximately

200t, was lifted from the stream

bed by the pressure force of the

descending "Wanglaui" and thrown

to its present location.

The boulder was carried over a distance of 46m at an altitude difference upslope of about 5m. Such avalanche relics are preserved indefinitely and bear witness to the large forces associated with avalanches. Ground avalanches generally carry with them a lot of dirt, stones and vegetation which is preserved long after the snow has melted.

A classic example from Engelberger Valley shows how the air blast and parts of large powder snow avalanches have an effect over long distances. From the area of the Wendenjoch and the Firnalpli glacier, the Firnalpli avalanche plunges down into the valley of the Engelbergeraa. The starting zone of this avalanche is large and measures about 150 hectares. The track is 2500m long, but slopes only 47% in the middle. The mountain pasture, Herrenrüti, is located opposite the avalanche slope on the other side of the valley. Above, it is bordered by the forested area of the Spicherrain at the foot of the Fürrenhohfluh. Within the last few years, the dust avalanche has repeatedly crossed the 560m wide valley and uprooted entire patches of forest on the opposite slopes. It even crossed the trench of the Aawasser, which is located in between the valley slopes and is 50m deeper than the destroyed forest areas. Strangely enough, buildings that were also situated in between escaped damage, but the avalanche coated the walls facing it with a hard layer of compacted snowdust. Through the years, avalanches have selectively uprooted mostly stands of spruce, but left standing deciduous trees, such as maple, ash, and beech which, defoliated, offer less exposed surface area.

It was mentioned in Chapter I that since 1955 a renewed effort has been made to compile a Swiss avalanche **cadaster**. All observations made dealing with avalanches should be recorded in this register. Avalanche slopes and avalanche areas in general should be marked on zoning maps that are drawn to scales of 1:50'000 to 1:10'000. A thorough description of every important avalanche should be attached. Such descriptions can be supplemented by sketches and photos. The quality of the register is dependent on the availability of topographic plans, and on the ability of researchers and local observers. Its usefulness for avalanche zone planning will therefore vary. One must be aware that in many cases, the register does not include

much of the past, especially records of unusual and extreme avalanches. But it is just these slides that are most important for avalanche zone planning. It is regretable that not much progress has been made in compiling a Swiss avalanche cadaster, but some cantons and many communities have not yet been included in the project. Summaries of avalanches which have caused accidents and damage, are published since 1936/37 by the SLF Institute in yearly winter reports. These reports can also be used as a source of information.

On-site inspection of the terrain offers one an opportunity of asking those who live and work there what they have observed about avalanches. Information given by laymen has to be accepted with caution. However, farmers who live in mountain areas often recollect clearly damage done to land, forests, living quarters and farm buildings remarkably far in the past. Such knowledge is often the only criterion regarding past avalanche occurrence.

Avalanche events have also been recorded as part of history. While most pertinent information must be collected laboriously from old calendars, palaeographs, community records, local magazines and local history, some towns and communities have maintained an avalanche chronicle of their own. Yet the historian was mostly interested in how many people were killed, and how many homes were damaged, than in giving information on the actual extent of the avalanche itself. But summary information in a chronicle can often yield valuable contributions. For example: one would have been much better advised in preparing the avalanche zoning map for the area of Egga Böden in Davos, if more weight had been given to information found in a chronicle dealing with the avalanche on 3 March 1609, rather than to recently observed avalanches.

Avalanche control structures in areas of avalanche zone planning must be examined to determine their effectiveness. Most supporting structures built in the starting zone of avalanches do not provide the necessary protection that was expected of them when installed. Opinions concerning the effectiveness of such structures are frequently too optimistic, but optimists are often desired in the realm of human relations. False optimism used in engineering these structures can have fatal consequences, for which several examples could be cited. Somewhat more caution and maybe more factual knowledge--good examples excepted--would be useful in building avalanche control structures. Proof of the effectiveness of supporting structures can often be obtained by simply looking at the state of the reforestation below them. If no success is observed with it, the control structures must be considered inadequate for that area. For many people, this is a bitter pill to swallow, but it must be strongly emphasized here to prevent future failures.

IV. Legal Aspects of Avalanche Zone Planning

It was pointed out in the chapter dealing with the historical aspect of avalanche zone planning that the tremendous construction developments in some tourist resorts have created new problems for the building commissions. An example is the protection of the population against avalanche danger. Under the pressure of necessity, certain communities established avalanche

zoning. When efforts were made to prohibit construction in these zones, the interests of the landowners clashed strongly with the interests of the communities. On one hand was the carefully guarded private ownership of the individual; on the other, the public-legal obligation of the community authorities to interfere and prevent disaster. Now the fact that a person might be willing to chance a dangerous situation will, according to existing law, not justify any action by police. Buildings in danger from avalanches, however, extend beyond the private interests of the builder, owner, and renters and become a matter of public concern. Even though these words are often used, a legally unambiguous interpretation of them is difficult. Not every constraint against economic advantages is in the public interest, but such an interest can be assumed in the case of avalanche zoning.

Occupation of a building presently implies the unquestionable assumption of the right to use public services: mail delivery, snow removal, fire department, police department, repairs by the telephone company, by the power and light company, the water department and many others. The danger present might also effect others: the milkman, the doctor and residents' children on their way to school. Should an accident happen, the rescue team would also be endangered. Famous resorts claim that avalanche disasters would damage their reputations. Buildings located in avalanche zones become a matter of great public concern, especially if the building of protective structures is later required. According to Art. 32, Paragraph 2 of the Executive Ordinance of the Federal Forest Law, no federal aid is given to build these structures. Such a case, although not clear, has already happened. Since 1952, many vacation houses have been built among several older buildings which are located in an avalanche area. The builders had been warned, then a disaster happened. Because of the older buildings, financial assistance should have been received, but payment could have been withheld, since warnings concerning the construction of the newer buildings had been disregarded. The Federal Government would not make the decision to withhold assistance and for many possible reasons, financial aid was given to build defense structures. These examples illustrate that even simple rules can lead to conflicts.

The expert opinion of Crespi was mentioned in the first chapter. It is based on a dissertation which analyzes the definition of "liberal police." Voigt defines police as follows: "Law enforcement is a purely defensive institution, founded to prevent danger in the areas of interior affairs by limiting freedom and ownership of citizens in the general interest of people, insofar as this is considered necessary to the maintenance of public security and order." Voigt explains further: "This formula gives in practice only summary information on how far police duties should be carried. It is totally dependent on the interpretation given to the terms 'general interest,' 'public safety' and 'public order.' The police authorities in the Federation and in the cantons base their authority on a general interpretation of police functions contained in the general clause, especially if their interference is necessary in the public interest, but cannot be based on a police ordinance. In an area not covered by law, the general clause is considered a prescriptive law."

This prescriptive law is ancient in origin. The police have always been directed by the administrators of public-legal bodies. In today's Confederation, to administer local police is a function of the political community and community council. The construction police are a branch of the local police. It has been layed down in the individual constitutions of the cantons, that it is the responsibility of the community agencies to deal with public safety and order. Their specific duties are regulated by community law, if one exists. To illustrate, the following is repeated here:

> Canton Zürich, the Law of June 6, 1926, concerning community affairs, paragraph 74: "In addition to duties specified by other laws, the community authorities must especially regulate local police power. They must enforce laws against public disturbances and uphold order. They are responsible for the safety of the citizens and their property against every kind of danger and damage, and must take all necessary precautions to see that duties of the local police are properly executed in all administrative areas."
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> Canton Berne, the Law of December 9, 1917, concerning community affairs, Art. 2, states: "The community must regulate the local police (security force, right of domicile, street and building police, field police, fire police, industrial police, resident regulations, health authorities, fire department, rural and forest guard, care for the injured persons and for strangers that are helpless and sick, etc.)." A decree from January 27, 1920, concerning the local police, paragraph 1: "The local police are an executive branch of the public administration within the limits of the community and responsible for upholding order and guaranteeing safety against disturbances and dangers brought about by living beings or events." -- "Also, when specific regulations do not exist for certain cases or when instructions given by the appropriate authorities are not available in time, the local police authorities must decide on appropriate measures themselves," (paragraph 5).
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> Canton St. Gall, Organization Law from December 29, 1947, Art. 52-54: "It is the responsibility of the community council to guarantee safety for citizens and property against any kind of damage or danger, and to uphold order and prevent public disturbance. The community council, acting as the local building police authorities, should prevent or eliminate any hazard associated with buildings, since such hazards might be dangerous to public safety and order."

As we see it, not only has the local police the right, but also the duty to interfere in careless and negligent building, especially if it is dangerous to the residents and if it is not in the public interest. Voigt cites two examples: the Glarner administrative adviser ordered the evacuation of endangered homes, when it became evident that part of the "Kilchenstock" would slide. The police prohibit skating on the only partially frozen Zürich Lake, since the skater not only jeopardizes his own life, but also the lives of possible rescuers and therefore disturbs the public order.

The liberal-democratic state, however, limits police power to protect its citizens from its misuse. Objections against the restriction of construction have been raised on this basis. It is argued that the construction of a home in an avalance area does not represent immediate danger to public safety and order. On closer analysis, it becomes clear that the true nature of avalanche danger is not recognized in such an argument. Avalanche danger can only be minimized by the use of preventive measures and according to presently existing legal interpretations, such measures are within legal limits. According to Voigt, the following reasons were given by Hatschek: "Should we wait until the lawmaker declares certain aspects of human activity illegal? If so, then the police would always be too late to prevent disaster. It also would be very difficult for the lawmaker to establish norms for regulating police power, if the police would not occasionally use power where no regulations exist." Can the construction of a home in an avalanche zone be considered as illegal? By searching through lawbooks, I could find the avalanche zone only once. In this instance, the question was debated, "Against whom should the police act in case of a natural catastrophe?" Müller gives the following example: "Let us imagine the poor mountain farmer from whose mountain pastures rockslides and avalanches endanger the traffic routes below. Here certainly exists an illegal condition of property which should be prevented by the police, if the means could be found to do so." Müller's investigations clearly showed that the local police has the right to intervene. First, we cite an older document: "The police are a public-governmental institution within the state. It is the arm of justice which is responsible for the maintenance of law and order. It must continuously and systematically observe all existing conditions and events, which relate to the order of things. It also must prevent any threat to law and order that is in the making, regardless of whether these threats are released by the forces of nature or if they are a result of human activities." Law experts, who do not understand the nature of avalanche danger, have depended mostly on Federal Court interpretations of police duties, where the word "immediate" is stressed. The following remarks are cited from Müller: "Serious danger, which is immediate, and obviously directed against the lawful execution of executive power or in public against the legal rights of people, such as their lives, their health, and their property should, according to circumstances and with the use of appropriate methods which are directed against the cause of danger, be prevented. In Switzerland, this should be the unquestionable and basic police duty of the state, which must be executed even if the appropriate laws do not exist." The author of this cumbersome statement probably had in mind a comprehensive definition of police duties, in case of police intervention. The defense against danger caused by natural events, which has not been included in this definition, should be part of such a general interpretation. It is clear that the presence of "immediate danger" cannot be required in this case, since without the preventive activities of the police, avalanche control would be ineffective.

The question of who is authorized to compile avalanche zoning maps must now be discussed. We have seen that as a rule, the community council

executes the duties of the building police. It not only can, but also must interfere in the case of careless building in an avalanche zone. The preliminary surveys for the building police is done by a special commission, whose members also include construction experts. This building commission must be prepared to handle all construction requests for areas with avalanche slopes. Most mountain communities have avalanche areas, for which zoning maps should be worked out as soon as possible, since the probability exists that they might be claimed in the future for building sites or tourist areas.

The designation, avalanche zoning "plan" can lead to confusion. The word "plan" can basically mean two different things: It can be a technical draft or the plan of a site and express a definite condition; or it can be a planning tool or an expression of what is intended. It must be emphatically stated that an avalanche zoning map has little or nothing to do with a planning right, but that it is an expression of a long existing state of affairs. Possible public-legal restrictions of the use of property are not a consequence of this map, but existed undiscovered long before. It is argued that on sites which are endangered by avalanches, construction cannot be categorically prohibited without the proper special-legal authorization; just as if such construction restrictions had not existed long before! Even if an avalanche zoning map does not exist, an avalanche area should not be sold by its owner as a potential building site. A police action does not initiate the limited use of property. Such a restriction is in existence before the action is taken. In summary: Restricting construction in an avalanche zone is not determined by avalanche zoning maps, but is a consequence of existing natural law. Therefore, avalanche zone planning is not a planning rights institution. Where the use of property is limited as a result of true planning, a thorough investigation concerning its legality is appropriate. The Federal Court practice of asking for the appropriate legal argument in this case must be recommended.

In this connection, it can be said that the Federal Building Law of the West German Republic is more rigorous. To control building activities outside closed settlements, paragraph 35 states that building is fundamentally prohibited in the remote areas. Estermann writes: "It is significant that according to German Law, construction projects in the remote areas are not permitted if funds have to be spent uneconomically on streets and other traffic installation, for sewer systems and supply installations, for safety, health, and other public necessities. This is independent of whether or not the community has to carry the financial burden for these projects. Construction of week-end cabins is also considered undesirable building and therefore not permitted."

However, we do not have a federal building law. The Swiss "Zivilgesetzbuch" (ZGB) (civil code) demands that the cantons regulate their own building rights, either with appropriate special laws or in the law supplementing the ZGB. The will of the lawmakers is expressed in the ZGB Art. 702, which states that the cantons and communities should have the right to limit the use of property in the public interest. That a public interest exists has

been proven. It is easy to understand that the use of property in avalanche areas is limited, a fact which should not need any further proof. We do not seek to discuss further here whether the subject of avalanche zoning should be mentioned in the legislature in order to achieve legal status for it. It would be easy to show that this subject was in part simply forgotten.

The opinion of the Federal Court and that of Crespi agree that avalanche zone planning should be incorporated into the law. This opinion, however, does not mean that the drafting of an avalanche zoning map is prohibited under present conditions. Such a map is at first only a technical tool used by the building police, and has no legal status. It serves only as a guide for the building commission. It helps them to speed up decision-making and to rationalize their activities. It does not prohibit construction. This is in every single case decided by the building authorities. These temporary difficulties and the lack of an appropriate law should not, under any circumstances, delay the authorities of mountain communities from immediately commissioning an avalanche zoning map.

Such maps already are of great practical importance. They provide fundamental information which is used as a guideline by the Elemental Damage Claims Insurance. This institution, which for example, is a public one in the cantons of Berne, Nidwalden, Glarus, Fribourg, St. Gall, the Grisons and Vaud, can exercise a definite influence against careless building. An additional influence can be exercised against inadmissible building projects by the community authorities in withholding connections to public utility facilities.

Now the question has to be examined if building restrictions resulting from avalanche danger are subject to compensation claims by the property owner. This has been categorically denied by qualified opinions. A memorandum to the expert opinion of Crespi states: "Compensation is only justified when, through building restriction, proper use and utilization of ground cannot be maintained. This is not the case here, since by restricting building no new situation has been created but an already existing danger has been officially recognized and confirmed." The expert opinion of Imboden states: "When it is justifiable to prevent property from being used because of avalanche danger, no compensation is permissible. This is valid even if presently, building site prices would be paid for the property." The legal opinion of today can be even further extended. Estermann cites the opinion of Liver: "Since agricultural areas are meant to be used for agriculture and not for construction, no compensation must be paid for building restrictions on agricultural soil." Stüdeli and Jost are also of the opinion that the restriction of construction in rural areas unfit for construction should not be compensated. The guidelines of the ORL Institute are also in agreement with this: "Prohibition of building in the interest of safety against the natural elements must not be compensated."

Of the 12 mountain cantons, only four mention avalanche zones in their special legislation. Surprisingly enough, it is also missing from the newer laws of four other cantons. It must be assumed that the guidelines prepared

in 1952 by the Federal Department of Interior have not reached all offices of building management. It cannot be assumed that they have been purposely forgotten, since all kinds of other subjects dealing with regional planning were itemized.

Technically, avalanche zones belong in the building code or in a planning code of higher order. In this case, a more systematic approach would be appropriate. For example, the canton Fribourg and the Grisons have incorporated avalanche zones into two different laws. Avalanche areas must be subsumed under danger zones in Art. 3, paragraph d in the cantonal Building and Planning Law of the Grisons. Earlier they were explicitly mentioned in Art. 48 of the cantonal Forest Law, even though they technically do not belong to it. The canton Fribourg does not mention avalanche zones in its building code, even though they should be itemized under Plan of Zones in Art. 34. Yet avalanche zones are mentioned in Art. 20 of the Executive Order, in the Law and Executive Order for the Fire Police, for the protection against damage from the elements, and in the law dealing with the insurance of buildings against fire and other damage. The large mountain cantons of Berne and the Valais do not mention them. In Art. 5, 6 and 9 in the Bernese law dealing with building specification, regulations of the building code are itemized. It also mentions zoning plans and green and open areas, but not avalanche zones. The canton of the Valais might have had the opportunity to mention avalanche zones when decreeing the regulation concerning the execution of the ordinance from January 28, 1963, dealing with subsidizing local and regional planning.

By legalizing avalanche zone planning so many legal and administrative affairs must be put in order, as we will see in the next chapter, that it cannot be done with one article or one paragraph of an article. Comprehensive regulations must be expected, which either should be incorporated in technically related codes, as for example the planning and building codes; or written as an independent law. The canton Nidwalden is the only canton that has such a law since 1964. The examples and considerations above should prove that certain guidelines de lege ferenda are necessary.

But who should work out these guidelines?

The guidelines of the Federal Department of Interior from June 17, 1952, concerning avalanche zoning plans, have been incorporated into the executive ordinance to the Federal Forest Law from October 1, 1965, concerning the federal supervision of the forest police. These guidelines remain valid. With the federal law from March 19, 1965, concerning measures to promote housing developments, it would be possible to exercise influence on a federal level. The 1. paragraph of Art. 4 states: "The Confederation will promote appropriate settlement at long sight and provide aid towards the cost of national, regional and local land planning insofar as it is used for this purpose."

Especially important is the new Art. 22^{quater} of the Federal Constitution which reads as follows: "The Confederation will decree basic regulations on land planning. These will serve the cantons to guarantee an appropriate use and settlement of the land. The Confederation promotes and coordinates the attempts of the cantons and works together with them."

V. Form and Content of the Avalanche Zoning Plan

The general plan for the register of land property at a scale of 1:10'000 is best suited for avalanche zone mapping. One to several sheets of that plan showing the different levels of danger is the technical basis for an avalanche zoning plan. These different levels are indicated with colors red, blue and white.

With red are indicated areas swept more or less frequently by avalanches or which after the topography must be considered as highly potential avalanche areas. Such areas normally cannot be used as building sites because avalanches occur too frequently or are too powerful. We consider one avalanche in 30 years or an avalanche pressure of 3.0 tons per meter square (t/m^2) or more as prohibitive.

The endangered area cannot exactly be deliminated. Avalanche activity gradually diminishes from the center toward the edges. In practice a transition zone colored in blue is put in between the area of manifest danger and that which is unquestionably safe. Danger is not as big to justify a total suppression of construction. However, a reduced hazard has to be taken into account when future damages and accidents shall be avoided. Blue areas can be used for building purpose only by observing certain restrictions. A reduced impact force of less than 3.0 t/m^2 of a "normal" avalanche which occurs at least once in 30 years has to be expected. Moreover this area can be swept by big and powerful avalanches as a result of extraordinary weather conditions. Such conditions however are seldom. For those cases an evacuation of the blue zone is provided. Local steep slopes where gliding is pronounced are also colored in blue.

Areas on which every risk resulting from snow and snow avalanches can be excluded are left white.

The avalanche zone map will become part of eventual local extension and alinement plans. In this respect, the existing graphical representations are not satisfactory. Red is used in construction plans only for housing development areas. Blue is reserved for water surfaces. It has to be determined if the color used for graphic representation in future avalanche zoning plans should be in accordance with the color used for graphic representation in general. For example: yellow-green with the designation AZ (Avalanche Zone) or DZ (Danger Zone) could be used for the hitherto "red zone" and cinnabar with the designation AZ for the hitherto "blue zone." The building authorities must now interpret and modify this plan with respect to building specifications. They, not the plan researcher, are responsible for a final zoning plan. The different construction zones must now be

coordinated with the corresponding danger zones. This procedure will be explained with examples. Let us assume that the avalanche zoning map indicates a small and safe area, which, from the village, can only be reached by crossing dangerous avalanche slopes. This area, being safe from avalanche danger, could be used for construction purposes. However, since the access route is dangerous, a risk exists not only for the residents but also for the public. In such a case, the building authorities will declare the area unsafe, or at least a blue zone area. Or a community may have sufficient building sites, but its ski runs and ski exercise areas which, are partly located in the blue zone, are endangered by building projects. It is obvious that such conditionally dangerous areas should be more heavily taxed and zoned against construction. This should be done for two reasons. First, the risk implied for buildings will be totally eliminated and, secondly, the terrain will be preserved for skiing. Such political considerations can modify the avalanche zoning map to a certain degree.

It is now necessary to incorporate these zones into land register plans of larger scales. The newer survey plans with a scale of 1:10'000 do not show property limits. However, it is necessary for the practical use of the zoning plans, that the location of every single parcel is clearly shown, relative to the different zones. The scales 1:1,000 to 1:5,000 are especially suitable for this purpose. Depending on how a parcel is divided by a borderline, it will be assigned to one or the other zone, according to its size and location.

Now it will be possible to determine building specifications for the different zones. These will prohibit construction in zones unfit for development. Definitions, however, are necessary. For example: building restrictions could not be applied to the construction of underground structures such as water reservoirs, or to temporary buildings used only in summer. It might also be permissible to allow farm buildings such as haylofts and summer stables, which are protected by avalanche control structures. On the other hand buildings connected with big traffic or gathering of people such as hotels and schools might be excluded from the blue zone.

The zone of transition, especially if it is broad, can be divided into smaller sections. This can be done by distinguishing between more and less endangered areas. It would be illogical to require building reinforcements to have the same load capacity on the edge of the "red zone" as on the edge of the "white zone." Therefore, avalanche pressure bands with ranges from 3.0 to 2.0 t/m^2, 2.0 to 1.0 t/m^2 and 1.0 to 0.0 t/m^2 can be provided. Eventually, a plan for evacuation must be drawn for the transition zone. The right to effect evacuation must also be contained in the regulations of the avalanche zoning plan. In practice the community authorities can only achieve an evacuation with the help of an Avalanche Warning Service. It has to give the technical advices. Therefore, such a communal service has to be provided necessarily for every settlement having "blue zones." As can be seen, the transition zone (blue zone) occupies a special position. A comment must be made now, which could have already been mentioned in the chapter

dealing with legal aspects. Because property rights should be protected as much as possible, the federal judicial practice requires an unquestionable legal foundation in order to effect general building restrictions or building limitations which must be evoked as a result of avalanche danger. It is the transition zone that leads to problems and which makes it difficult to arrive at decisions that satisfy public and private interests. It is inherent in the peculiarities of avalanches, especially the ones that occur at greater time intervals, that their extent and therefore their potential to do damage, can only be estimated. Therefore, small errors can be introduced even by qualified plan researchers, since no one is in the position to state objectively what exactly will happen. Such a possibility should not be a reason to decide in case of doubt in favor of the landowners since this could result in a decision which is neglecting the appropriate safety requirement. We should be aware that a wrong decision can have catastrophic consequences.

Another, and to my knowledge still unsolved, problem has been introduced by Schwarz at a convention of the Working Group for avalanche defenses. He asked the following question: "Is the federation ready to subsidize control measures in favor of avalanche-endangered "blue zones?" The answer of the Federal Forest Inspector was that a generally valid answer could not be given at this time.

The Federal Land Register is an excellent tool to assure safety in property transaction. The results of avalanche zone planning should also be incorporated into the Land Register. Unless this is done, the possibilities available through the Land Register and the pertinent plans cannot be fully exploited. The "Instruction for the Demarcation and Parcel Survey" from June 10, 1919, states in Art. 28, Lit.g, that in a survey, objects such as rockslides, avalanche slopes, cliffs, scree slopes, and landslides should be recorded. One of the most important aspects of property description in avalanche areas is the stipulation that the property might be endangered by avalanches. Moreover, interested buyers should be alerted to the danger by an annotation; it can then be assumed that everyone is aware of avalanche danger. The objection that someone might have no knowledge of it is virtually impossible. The annotation also offers assurance that claims appearing later for public money for control structures (Executive ordinance to the Federal Forest Law, Art. 32, paragraph 2) can be turned down.

Through the Land Register, the Avalanche Zoning Plan also obtains a status of private-legal importance, in addition to the prominent public interest. As a result, the safety in property transactions is increased to the great satisfaction of honest property speculators, but to the disadvantage of irresponsible speculators. Much argument could have been prevented if the buyers, mostly strangers to the locality, could have had access to neutral information before signing a contract. Such information could have provided him with knowledge about the location of the property with respect to avalanche danger, and danger from natural elements in general. The Land Register can give the avalanche zoning plan the necessary publicity.

Another private-legal aspect of avalanche zone planning is the obligation right (OR). In part, irresponsible property sales have been made by selling building sites in avalanche-endangered areas to credulous buyers. How well the seller was informed about the danger would be in most cases impossible to determine. According to Art. 197 OR, the seller is legally responsible to the buyer, for the qualities assured by him for the object of sale. This holds true, even if the transaction is not recorded, since it is assumed that the buyer acquires a "building site" with the intention of actually using it for construction purposes. Art. 197 is not only valid for buying movable goods, since according to Art. 221 OR, the regulations dealing with the buying of movable goods can also be applied to buying of property. The cheated buyer would then have, according to the principle of acceptance of responsibility, the right to ask the former owner for reparations.

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